Estimated Number of Interactions

Abstract: The total number of neutrino interactions in the emulsion is estimated using the Monte Carlo with neutrino production estimates.

Analysis

The Monte Carlo is used for three main functions in this analysis:

1. Generate *ν*s in the dump
2. Propagate *ν*s to the emulsion target
3. Assign a weight ∝ production kinematics
4. Assign a weight ∝ interaction probability

The separation of production weight and interaction weight is necessary here. As a reminder, the number of interactions is given as:

$$N_{\text{int}} = \frac{N_\nu \sigma N_{\text{nucl}}}{Area} = \left(\frac{N_\nu}{pot}\right)(pot)\left(\frac{1}{Area}\right)\left(\sigma^{\text{const}}\right)\left(\frac{m_{\text{tgt}}}{m_{\text{nucl}}}\right)\sum E_i \cdot K(E_i) \cdot T_i \cdot t_i$$

where σ^{const} is the energy-independent part of the neutrino-nucleon cross section, m_{tgt} is the emulsion target mass (e.g. the *pot*-weighted average), m_{nucl} the nucleon mass, E neutrino energy, K additional kinematic suppression (τ only), T the binary (0 or 1) for ν in the target and t the binary for the trigger.

$$F_e = \left(5.88\times10^{-4}\right)\left(3.54\times10^{17}\right)\left(\frac{1}{2400 cm^2}\right)\left(0.505\times10^{-38}\right)\left(\frac{260 kg}{1.66\times10^{-27} kg}\right)$$

Inserting numbers for the constant part yields

This gives 68.7 for electron-neutrino interactions. The same number will be used for muon-neutrinos, and the value for tau-neutrino interactions is 10.6. The values for number of neutrinos created per *pot* are from Emily's thesis.

The part in the summation in the first equation is evaluated as one number for each flavor.

Flavor	N_ν/pot	$\Sigma EKTt$	F_j	**Π**
e	5.88×10^{-4}	4.47	68.7	307
μ	5.88×10^{-4}	7.67*	68.7	527
τ	9.08×10^{-5}	2.70	10.6	29

The total number of triggered interactions is estimated to be 863. The total number of interactions ($t\equiv1$) is 931. This may be low because to estimate the number of located events, we need to multiply by electronic, scan and location efficiencies. This is

typically $0.68 \times 0.67 = 0.46$. Thus, our estimated number of located events is $0.46 \times 863 = 397$.